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UNITED STATES DEPARTMENT OF AGRICULTURE

The Corn Earworm as an Enemy of Vetch



VETCH, which has become an important forage crop throughout the Southeastern States, needs protection from the same insect that works such havoc on corn and cotton. This corn earworm, or cotton bollworm, is the most serious pest that growers of vetch have to combat. The caterpillars eat both the foliage and the seed pods, and, if the infestation is heavy, make the crop practically worthless.

Vetch intended for a hay crop generally escapes serious injury, as it is cut before the caterpillars are large enough to do much damage. It is recommended that a crop intended for seed be carefully watched and if the insects become numerous an insecticide be applied at once or the vetch cut for hay.

Spraying, dusting, the use of poisoned-bran bait, and other control measures are discussed and summarized in this bulletin.

Contribution from the Bureau of Entomology

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CORN EARWORM AS AN ENEMY OF VETCH.

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THE corn earworm is the worst insect enemy of vetch. It is one of the oldest known, most destructive, and most widely distributed insect pests and has many names descriptive of the injury it does to different cultivated plants. Of these names the most common are corn earworm, tomato worm, "tobacco budworm," and cotton bollworm, the last being used in the cotton belt.

The corn earworm occurs throughout the United States, where in the North it injures mainly green corn in field and garden, and in the South corn (figs. 1 and 3) and cotton, especially in the western portions of the cotton belt. Tomatoes and various other truck crops at times suffer severe injury. Recently the corn earworm has become a serious pest of alfalfa and especially of vetch in the South Atlantic States.

The annual damage caused by the corn earworm to cultivated crops, exclusive of alfalfa, has been estimated at \$27,000,000. The damage is done solely by the caterpillars, which are extremely ravenous and consume enormous quantities of food daily



FIG. 1.—Corn earworm and its injury to ear of field corn. (Quaintance and Bruce.)

during the period from the time they issue from the egg until they are ready to transform into the pupa or resting stage. They feed all day long even during bright sunny weather, a habit not usual with other caterpillars.

Although considerable damage is done by the caterpillars eating the foliage of vetch, the greatest injury is done to the pods, which they enter in search of seed (fig. 4). When grown with oats for a hay crop, vetch may escape serious injury, as generally it is cut before the caterpillars are of sufficient size to do serious damage. When vetch is intended for a seed crop, however, or when part of the crop is left for seed, injury may be much more severe; for by the time the seed pods are well developed the caterpillars are about full grown and require a large amount of food. During a serious infestation the damage to the crop may be so great as to render it practically worthless for seed.

Pods which have been robbed of their seeds by the caterpillars often show no visible evidence of injury other than a small hole in the side made by the worm upon its entrance or exit. If such a pod be opened it will be found that all the seeds have been eaten. Sometimes, however, the sides of the pods are much damaged; in fact, often eaten half away.

WHAT THE CORN EARWORM EATS.

The corn earworm is practically omnivorous. Besides feeding on vetch, corn, cotton, tobacco, alfalfa, and tomatoes, it has a variety of food plants upon which it may subsist. Some of the more important are beans, pumpkins, peanuts, squash, cowpeas, pepper, asparagus, and sunflower. The caterpillars have also a cannibalistic habit, which is especially noticeable when a number of the caterpillars are closely confined. In such instances there is a battle to death, the victors devouring their antagonists. These caterpillars also feed upon other soft-bodied insects and are known to feed upon both the caterpillars and the pupæ of the alfalfa caterpillar, a most destructive insect pest of alfalfa in the southwestern United States.

WHEN A SERIOUS INFESTATION MAY BE EXPECTED.

Cool, moist weather favors an outbreak of the corn earworm on vetch, not only because this kind of weather is favorable for the development of the insect but also because it is conducive to a luxuriant and dense growth of the vetch. Then, also, during such weather conditions the insect enemies of these caterpillars are hindered in their work. Cold weather has no apparent effect on the pupæ in regions where the insect is a pest of vetch because they are

at that time underground and are not seriously affected by such freezes as occur in that latitude.

MOTH AND CATERPILLAR.

The adult of the corn earworm, or cotton bollworm (fig. 2), is a moth or miller which varies in color from a dull olive green in the male to a reddish brown in the female. It is to be seen flying about just before dusk in corn, cotton, and vetch fields, and at midday it may be found resting in the throat of young corn. Few growers recognize in this moth the parent of the corn earworm. The full-grown caterpillars attract more notice because they make their presence known by serious injury to crops.

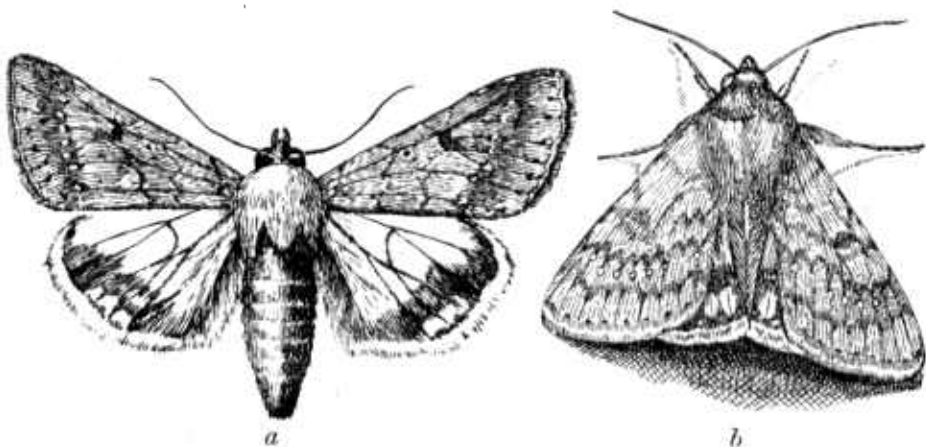


Fig. 2.—Adults of corn earworm: *a*, With wings spread; *b*, in resting position, wings folded. Twice natural size. (*a*, Original; *b*, from Quaintance.)

CLOSELY RELATED SPECIES.

This moth is a member of the family of night-flying insects commonly known as “millers.” The group is a large one, including many of our most injurious caterpillar pests. Among them are the common cutworms of the garden and field, the true army worm, the fall army worm (or grass worm), and the true tobacco budworm, all of which show habits similar to those of the corn earworm.

The caterpillar of the corn earworm has been confused with the army worm, especially the fall army worm, because of the fact that when on vetch it feeds gregariously, or in colonies, and when the crop is cut moves or marches in “armies” to other fields.

SEASONAL HISTORY.

From South Carolina southward in May and June the first generation is destructive to vetch, alfalfa, young corn, and cotton. The second, which makes its appearance in the latter part of June and

becomes abundant during the month of July, is injurious to corn as it comes into silk and tassel. The moths are attracted to the silk and leaves where the eggs are deposited. This is the most destructive generation to corn. The caterpillars feed on the silks, later



FIG. 3.—Corn earworm injury to bud (at left) and tassel (at right) of corn. Reduced nearly one-half. (Qualintance and Brues.)

on the kernels of the ear, and when full grown bore out through the husks, crawl down the plant, and enter the ground to pupate.

The third, or August, generation is attracted to cotton, attacking it at the time when most of the corn in southern fields is maturing



FIG. 4.—Work of corn earworm on vetch.

and, therefore, is no longer suitable as food for the caterpillars. Late corn, however, is damaged considerably by the larvæ of this generation, the percentage of infested ears sometimes running high. Tobacco is subject to injury about the same time. In cotton the



FIG. 5.—Tip of ear of corn, showing eggs of corn earworm on the silks. In upper right, a few eggs on silks, enlarged. (Quaintance and Brues.)

worms bore into the bolls. The fourth generation, which occurs only in the most southern portions of the country, is rarely important, since food is scarcer and weather conditions less favorable and their number usually has been reduced by parasitic enemies. The over-

lapping of the generations makes it possible to find all stages of the insect at any time during the summer and fall months.

LIFE CYCLE.

The corn earworm in its life history passes through four distinct stages: First, the egg (fig. 5); second, the larva or caterpillar (fig. 6); third, the pupa or resting stage (figs. 7 and 8); and, finally, the moth or mature insect (figs. 2 and 9).

THE EGG.

The egg (fig. 5) of the corn earworm moth is hemispherical in outline and somewhat smaller than a pinhead. It is a uniform light yellow when just deposited, but towards the end of the incubation period it becomes mottled with reddish brown. The duration of the incubation period varies from 3 days in summer to from 5 to 8 days in early spring or late fall. There is also a great variation in the number of eggs deposited. A moth deposits on an average about 800 eggs during her lifetime and about 300 during an evening. She may deposit as many as 500 eggs in one evening, however, and over 2,500 during her lifetime. The eggs are deposited singly, just before dusk, on various parts of plants upon which the caterpillars feed.

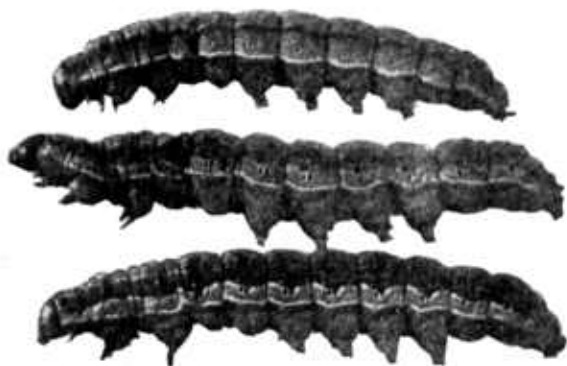


FIG. 6.—Three corn earworm larvæ, seen from the side, showing color types: Upper larvæ, green; middle one, rose colored; lower one, dark brown. Twice natural size. (Quaintance and Brues.)

THE LARVA OR CATERPILLAR.

The caterpillar or larva (fig. 6) is the stage in which the insect attacks and destroys the plant. The newly-hatched caterpillar is pale yellowish white with a pitch-black head. It walks with a looping motion somewhat similar to that of a "measuring worm." This is due to the second and third pairs of legs being shorter than the first in the young larvæ. In the full-grown individuals they are all equal in length.

The body of the caterpillar is covered with numerous wartlike humps of a dark color, each one of which bears a short hair. These

humps are known as tubercles and give the caterpillar a spotted appearance even when young but more so when almost full grown. As the caterpillar grows the skin is shed periodically, usually every two to four days. This shedding of the skin is known as molting. The caterpillar molts at least five times, sometimes more. When full grown it is about $1\frac{1}{2}$ inches long. After every molt the caterpillar takes on a new color pattern, quite different from the preced-

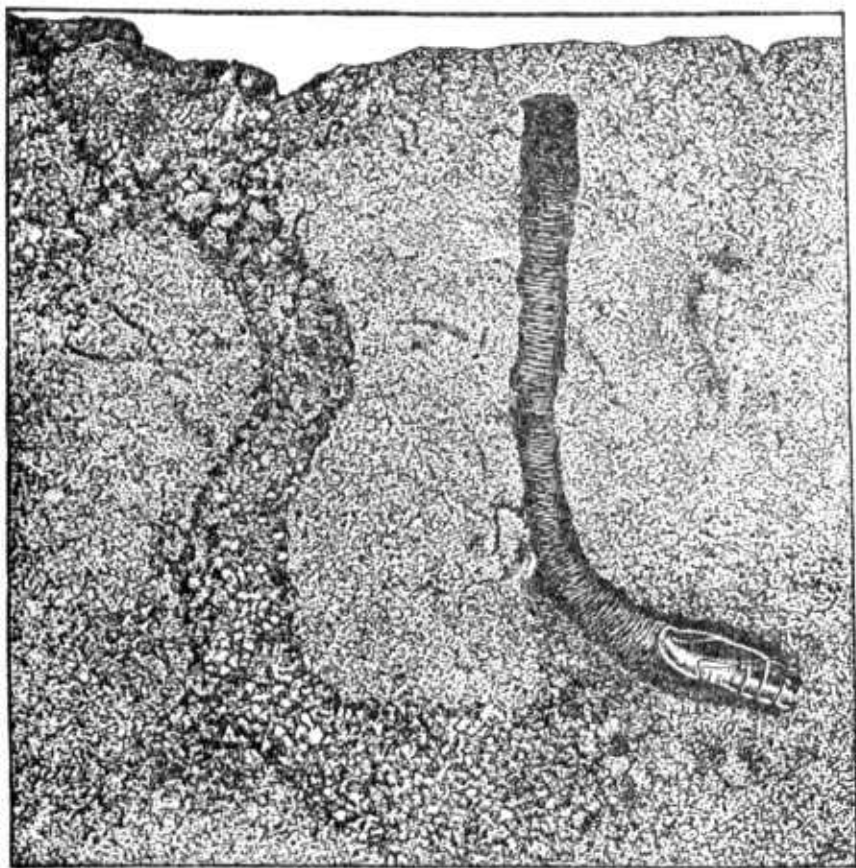


FIG. 7.—Pupa of corn earworm in its burrow in the soil. (Copied from Quaintance and Brues.)

ing one. Full-grown caterpillars vary greatly in color; in fact, if individuals showing extremes in color were selected, the average person would not recognize them as belonging to the same species. The color varies from a pale green to a very dark brown, almost black. Between these extremes are many shades and combinations of colors. Some have beautiful stripes or bands of yellow on the sides and almost black or olive on the back.

Caterpillars when feeding on foliage such as vetch show a somewhat darker color pattern than when feeding on corn ears or in cot-

ton bolls. There are two common forms found in such places. One form has a dark amber head mottled with dark brown and a body that is almost black. Over the middle of the body are whitish lines running lengthwise. Along either side is a light-colored band. These bands usually are yellowish in color. The underside of the body is yellowish white and the feet are dark. The other form has a head of the same color as the preceding, but the body presents a marked difference in color pattern. The back is an olive gray with two narrow black lines close together running lengthwise over the middle. Along either side is a black band, and directly below it is a light one having the same color as in the other form. The undersides of the body and feet are as in the preceding form. Other forms are modifications of these.

The skin of this caterpillar is finely granulated and somewhat greasy in appearance. That of the fall army worm or of the true army worm is smooth and shiny. This difference aids in identification of the caterpillar.

The length of life of the caterpillar depends upon the temperature of the period during which it lives. During the spring and early summer when the temperatures are not so high the length of this stage is from 22 to 28 days with an average of about 24 days. During the summer months this stage is somewhat shorter.

Coming from eggs that were deposited at short intervals, the caterpillars reach maturity at about the same time and consequently undergo the transformation stage together. This explains why caterpillars may be seen in countless numbers in the evening and by the next morning may have disappeared entirely, causing great astonishment to the planter.

THE PUPA OR RESTING STAGE.

Upon reaching maturity the caterpillar burrows into the soil to a depth of about 6 inches—the actual depth depending upon the texture of the soil. A burrow is then constructed which runs backward and upward to within a few inches of the surface of the soil so that the moth upon emergence will be able to come out of the ground without any difficulty. (Fig. 7.) The caterpillar changes to a pupa at the bottom of the burrow. The shape and general appearance of the pupa may be seen in figure 8. The pupa is reddish or light brown,

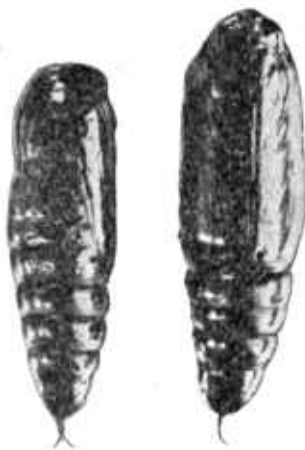


FIG. 8.—Pupa of corn earworm. Twice natural size. (Qualin-
ance and Brues.)

and highly polished. It is rather stont, about three-fourths inch long, and its last abdominal segment is supplied with two slender spines known as the cremaster. The time spent in this stage varies from 8 to 14 days during summer, and is much longer in early spring and in the late fall. The insect passes the winter in the pupa stage,

and the moth emerges early the following spring—earlier in the southern regions than in more northerly ones.

THE MOTH OR ADULT.

The moth of the corn earworm (fig. 9) is about three-fourths of an inch long with a wing expanse of about one and three-fifths inches. The moths are of different colors, the variation being sexual. Because this appears not to have been noticed heretofore, a brief description of the color of the two sexes follows:

The males are a light to a dull olive with dusky spots on the forewings and a



FIG. 9.—Moths of corn earworm resting on corn ear.

circular spot with a black center about midway between the apex and base on the costal angle of either wing. The hindwings have dusky bands near their outer angles. Veins of the hindwings are prominent and dark.

The females are fawn-colored with irregular spots of black on the forewings, often having dark bands near the outer angles of these wings. The circular ring so conspicuous in the forewing of the male is almost wanting or if present is merely a solid dark spot. The hindwings have broader and darker bands near their apical angles than those of the males.

The moths conceal themselves among the foliage during the day and come out at dusk to lay eggs and to feed upon the nectar and sweet juices of various plants. They live about 10 days or two weeks and during this time they mate and deposit their quota of eggs for the next generation.

INSECT ENEMIES.

The corn earworm when feeding on roasting ears or in cotton bolls is afforded much protection from its natural enemies. When feeding in the open on vetch and other crops it is attacked by numerous parasitic enemies. Chief among these are parasitic flies (fig. 10). These flies can be seen flying about in the field and depositing their eggs on the backs of the caterpillars. The eggs are whitish, somewhat oval, and about the size of a small pin-head; they can be seen quite readily with the unaided eye. A number of eggs may be deposited on the back of one caterpillar. The maggots hatching from these eggs enter the caterpillar's body, feed upon its tissues and organs, and gradually kill it. When mature the maggots leave the body of the caterpillar, which often has been eaten completely with the exception of its skin, and enter the ground to transform. The skin of the maggot hardens into a leathery case, dark red in color, termed a puparium, within which the transformation to adult takes place. The insect remains in the pupa stage about 10 days and at the end of the period the fly emerges.

These flies make known their presence by their high-pitched, humming sound when flying about fields in search of caterpillars upon which to place eggs. Among the more important bird enemies of the corn earworm are blackbirds, crows, sparrows, bluebirds, and meadowlarks. Domestic fowls are useful in reducing the numbers of the caterpillars. Toads also devour large numbers and have been found very commonly in vetch fields infested with these caterpillars.



FIG. 10.—*Winthemia quadripustulata*, a fly parasite on the corn earworm: Adult. Much enlarged. (Walton.)

CONTROL MEASURES.

In many cases during recent invasions of the corn earworm, the infestation started in hairy vetch and spread thence to young corn, cotton, and alfalfa. Growers who have suffered from invasions of this pest have hesitated about continuing to plant vetch. However, it is not necessary to reduce the acreage of vetch as this pest can be controlled by a little effort. As has previously been mentioned, vetch intended for a hay crop generally escapes serious injury because it usually is cut before the caterpillars are of sufficient size to do much damage. That part of the crop, however, which is intended for seed and which is left uncut for several weeks longer, that the seed may ripen, is subject to more serious injury; for during this period the caterpillars do their most destructive work. The seed crop of vetch, therefore, should be carefully examined from time to time; and if the caterpillars are found to be abundant, an insecticide should be applied at once, or if it is not possible to do this, the crop should be cut for hay. The quality of hay will not be as good as that from earlier-cut vetch, but the hay will be worth more than the small quantity of seed that the crop will yield.

During favorable seasons vetch and oats, planted together in rich soil, generally make a very dense growth. Therefore it is not advisable to use a large sprayer to apply an insecticide, for not only is it difficult to apply a spray so that it will reach the lower parts of the plants but the trampling of the dense growth of the crop results in much damage to the plants by their being broken off, bent over, or mashed down. The area to be treated is generally small and may be easily treated with portable machines, either sprayers or dusters. Every farmer should possess such an outfit. They are not necessarily expensive and may be purchased in almost any town. Often such an implement will more than pay for itself with a single usage. Every farmer should keep in touch with a concern that supplies standard insecticides, such as arsenate of lead, Paris green, or calcium arsenate. He should also keep in touch with an entomologist who can supply the necessary advice immediately. Nearly every State in the Union has such an official. It would be advisable also to have on hand a copy of *Farmers' Bulletin 908* on "Information for fruit growers about insecticides, spraying apparatus, and important insect pests."

SPRAYING FOR THE CATERPILLARS.

When the caterpillars are feeding on the foliage of plants, such as vetch or alfalfa, they may be killed by applying a poison spray (fig. 11). This spray should be applied with as much force as possible so as to reach the foliage at all depths. A mixture of 1 pound of

arsenate of lead (powder) or 2 pounds of arsenate of lead (paste form) to 50 gallons of water may be used. Paris green may be used in place of arsenate of lead, but is less desirable on account of the greater danger of burning the foliage. When Paris green is used it should be mixed with lime in the following proportions: Paris green, 10 ounces; freshly slaked lime, 2 pounds; water, 50 gallons. Zinc arsenate also may be used safely as a spray in the proportion of 1 pound to 50 gallons of water. Care should be taken when spraying young corn to see that the spray reaches well down into the bud.

DUSTING.

Since the advent of dusting as a means of controlling the cotton-boll weevil in the South, this method (fig. 12) of applying a poison for other insects is gaining in popularity. New and better dusters are now made and are almost as easily obtainable in the South as are spraying machines. Calcium arsenate or lead arsenate (powder form) may be used in any one of these dusters with satisfactory results. During a recent outbreak of the fall army worm in a certain district in the South splendid results were obtained with the use of a hand duster and calcium arsenate.

Dusting should be done early in the morning when the dew is still on the plants, or late in the evening. A little slaked lime may be added as a carrier but these insecticides are more effective when used in the pure form. There is no danger of burning the plants when lead arsenate is used in this way or when calcium arsenate is used, provided this arsenate shows not over three-fourths of one per cent of water-soluble arsenic. However, calcium arsenate having water-soluble arsenic in excess of three-fourths of one per cent should not be applied in the pure form but should be mixed with lime. If Paris green is used as a dust, freshly slaked lime should be added at the rate of 1 pound of Paris green to 3 pounds of lime.



FIG. 11.—An inexpensive type of outfit which may be used for spraying vetch or alfalfa.

POISONED-BRAN BAIT.

The poisoned-bran bait, used under some conditions, is a valuable means of controlling the corn earworm on vetch and on alfalfa. It is made as follows: Wheat bran 50 pounds, Paris green or white arsenic

1 pound, or powdered lead arsenate 2 pounds, low grade molasses 2 gallons, water 3 to 4 gallons. The bran and insecticide are first mixed together dry, the molasses is then added, and the whole mass is thoroughly combined. Five pounds of salt may be added to the mixture to keep it from drying out. The addition of six finely chopped lemons or oranges to the mixture to give flavor has been found to be advantageous in some cases, and water may be added when necessary.



FIG. 12.—Hand duster which may be used in applying calcium arsenate or lead arsenate to forage plants infested with corn earworms.

When scattered over the fields thinly it is effective with caterpillars moving to an uninfested field.

MECHANICAL METHODS OF CONTROL.

Before cutting the vetch in a seriously infested field a deep furrow should be made around it, because the caterpillars begin to leave a field while it is being cut, spread in all directions, assume the army worm habit, and, if nothing is done to prevent their onward march,

will pass to other fields and destroy crops growing there. Cotton and corn growing next to vetch have been completely overrun by caterpillars acting in this manner. If a deep furrow is made with a turn plow (fig 13) in the path of advance the caterpillars, in their endeavors to cross the ditch, will fall into it and become entrapped. They may then be sprayed with kerosene or crude oil, or a log may be dragged through the furrow to crush them. Holes may be sunk at frequent intervals in the bottom of the furrow for entrapping the worms. Where the worms attempt to cross a smooth, hard road in



FIG. 13.—Plowing a furrow around a field to be protected from corn earworms on the march. The man in the foreground is digging post holes at intervals to entrap the worms.

going from an infested field to a new field, a field roller run up and down the road gives excellent results in destroying them.

SUMMARY OF CONTROL MEASURES.

(1) A practical spraying outfit or duster should be kept on hand; also standard insecticides.

(2) In the spring watch carefully the vetch crop, and at the first sign of caterpillars apply the control measures recommended in this bulletin.

(3) In case the infestation is beyond control the crop should be cut for hay immediately. The ground should then be well cultivated so as to expose the pupæ to the hot sun and to their natural enemies.

(4) When the caterpillars are on the march, or are starting in one corner of a new field, stop their onward march by plowing a deep furrow around the infested area. Care should also be taken to see that the furrow is kept free from rubbish.

(5) As a spray for vetch and other forage crops use any one of the following mixtures:

(a) Arsenate of lead (powder form)	pound--	1
Water	gallons--	50
(b) Arsenate of lead (paste form)	pounds--	2
Water	gallons--	50

As a spray for corn use a stronger solution:

(a) Arsenate of lead (powder form)	pounds--	2
Water	gallons--	50
(b) Arsenate of lead (paste form)	pounds--	4
Water	gallons--	50

(6) In dusting use one of the following insecticides:

- (a) Calcium arsenate. Undiluted if analysis shows not over three-fourths of one per cent water-soluble arsenic, and diluted with lime if analysis shows over three-fourths of one per cent water-soluble arsenic.
- (b) Arsenate of lead (powder form).
- (c) Paris green 1 pound; lime, freshly slaked, 4 pounds.

(7) Poisoned bait is scattered broadcast over the infested fields. Make this up according to the following formula: Wheat bran 50 pounds, Paris green or white arsenic 1 pound, cheap molasses 2 gallons, water 3 to 4 gallons, and add 6 finely chopped oranges or lemons to the mixture.

CAUTION: Care should be taken not to pasture stock on crops that have been sprayed or dusted with poison mixtures until rains have removed all traces of the poisons.

PUBLICATIONS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE RELATING TO INSECTS INJURIOUS TO CEREAL AND FORAGE CROPS.

AVAILABLE FOR FREE DISTRIBUTION BY THE DEPARTMENT.

- Chalcids-Fly in Alfalfa Seed. (Farmers' Bulletin 636.)
Wireworms Destructive to Cereal and Forage Crops. (Farmers' Bulletin 725.)
True Army Worm and Its Control. (Farmers' Bulletin 731.)
Corn and Cotton Wireworm in Its Relation to Cereal and Forage Crops, with Control Measures. (Farmers' Bulletin 733.)
Cutworms and Their Control in Corn and Other Cereal Crops. (Farmers' Bulletin 739.)
Alfalfa Weevil and Methods of Controlling It. (Farmers' Bulletin 741.)
Grasshopper Control in Relation to Cereal and Forage Crops. (Farmers' Bulletin 747.)
Fall Army Worm, or Grass Worm, and Its Control. (Farmers' Bulletin 752.)
Bollworm or Corn Earworm. (Farmers' Bulletin 872.)
Rough-Headed Corn Stalk-Beetle in Southern States and Its Control. (Farmers' Bulletin 875.)
Common White Grubs. (Farmers' Bulletin 940.)
Controlling the Garden Webworm in Alfalfa Fields. (Farmers' Bulletin 944.)
Southern Corn Rootworm and Farm Practices to Control It. (Farmers' Bulletin 950.)
Controlling the Clover-Flower Midge. (Farmers' Bulletin 971.)
Control of the Green Clover Worm in Alfalfa Fields. (Farmers' Bulletin 982.)
How to Control Billbugs Destructive to Cereal and Forage Crops. (Farmers' Bulletin 1003.)
Wheat Jointworm and Its Control. (Farmers' Bulletin 1006.)
Larger Corn Stalk-Borer. (Farmers' Bulletin 1025.)
European Corn Borer: A Menace to the Country's Corn Crop. (Farmers' Bulletin 1046.)
Hessian Fly and How to Prevent Losses from It. (Farmers' Bulletin 1083.)
Grasshopper Control in the Pacific States. (Farmers' Bulletin 1140.)
Studies on the Life History and Habits of the Jointworm Flies of the Genus *Harmolita*, with Recommendations for Control. (Department Bulletin 808.)
Clover and Alfalfa Seed Chalcids-Fly. (Department Bulletin 812.)
Western Grass-Stem Sawfly. (Department Bulletin 841.)

